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# (54) Extruder roller die machines

(57) A screw 30 feeds material to the rolls 16, 18, of the machine, which are mounted for movement along planes which are oblique to one another and to a centre plane X, of the machine to give improved force distribution to the frame 50 of the machine and to give ready access to the machine for cleaning purposes. The planes of movement may be at angles A,B of 15° to 60° to a plane perpendicular to the plane X. The movement is effected by the roll bearings 58, being displaceable along slots 60 of the frame 50, by hydraulic cylinders 62 which also act to determine the nip between the rolls 16, 18.

A sensor 75 may act to control the speed of the rolls 16, 18, or of the extruder screw 30, or the size of the roll nip by regulating the hydraulic pressure of cylinders 62, or the heat transfer of the rolls 16, 18, or of the extruder die 46.

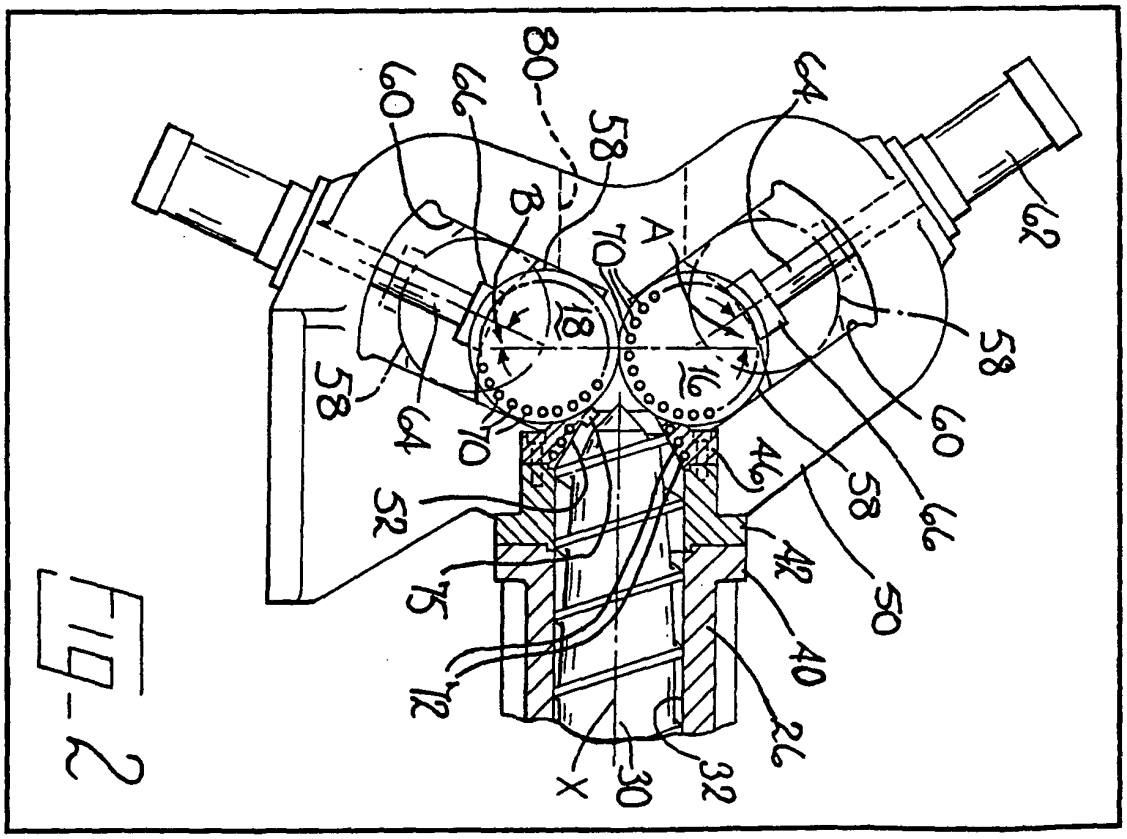


FIG 2

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Fig_1

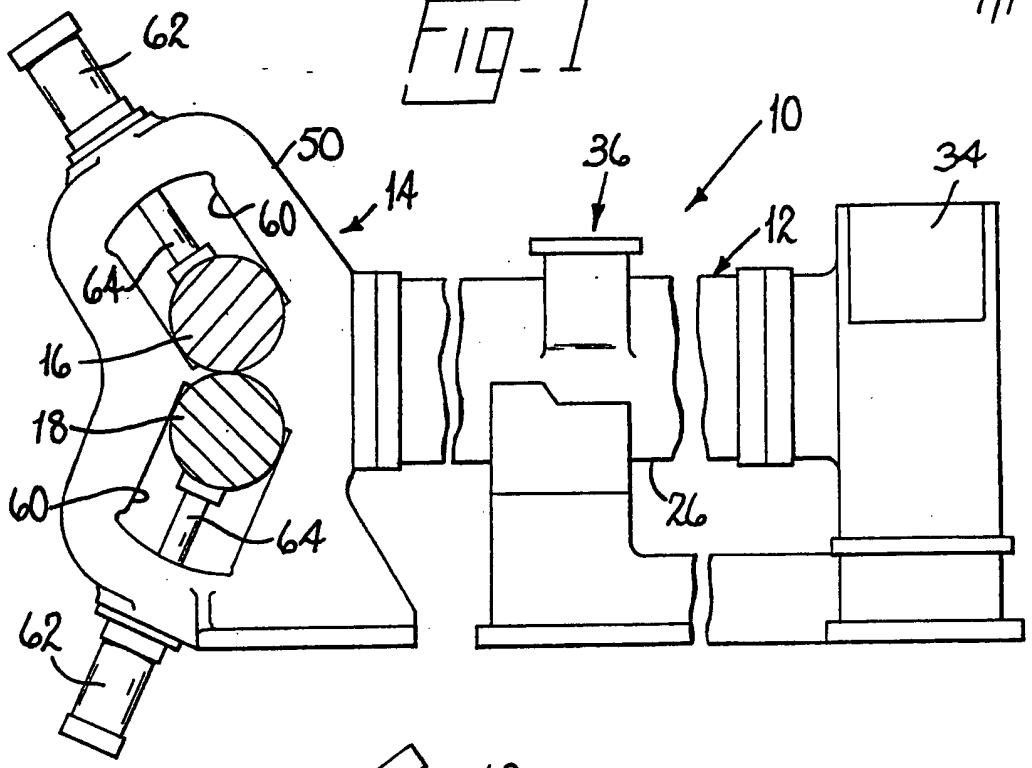
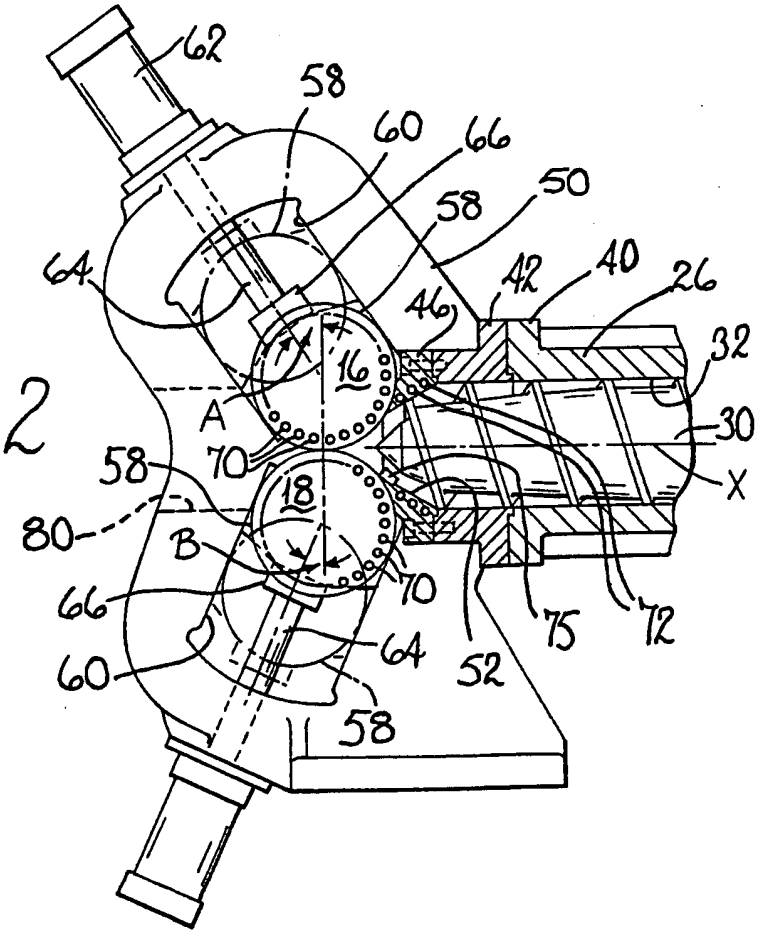

62
50
14
60
64
16
18
60
64
62
36
10
34
12
26

Fig_2


62
58
60
66
50
58
64
42
40
26
46
32
16
A
30
70
58
18
X
80
B
70
66
75
72
64
60
52
58

SPECIFICATION

**Extruder r ller di machines**

This invention is concerned with extruder roller die machines which comprise an extruder portion and a roller die portion.

Heretofore known extruder-roller die machines comprise an extruder portion in which a plastics or rubber material is mixed and propelled along the length of a cylinder or barrel, through a discharge orifice, and introduced between cooperating die rolls of a roller die portion which form the material to the finished dimensions. The material is discharged into the area between the rolls under heavy pressure.

It has been found in practice that as the material is introduced into the nip between the rolls, excessively high pressures may be exerted on the rolls themselves, which may occur at a time when the extruder is delivering to the rolls a volume of material in excess of what the rolls can deliver as output. An excessive pressure may also occur due to an unusually high viscosity of the material being formed. This could build up an accumulation of material which the rolls could not immediately handle, and which would require the shutting down of the entire machine involving the attendant removal of the excess material and cleaning of the equipment after gaining access to the parts of the machine requiring cleaning e.g. by moving portions of the roller die portion away from the extruder portion on rails or wheels, and thereafter reassembling the machine to put the machine back into productive use. This machine downtime reduces efficiency and increases costs. The need for portions of the machine to be mounted on rails or wheels also adds to the cost thereof. It has been proposed in U.S. Patent No. 3,115,672 to move the rolls apart, orthoganally to a machine axis, to permit cleaning and inspection thereof, provision for which movement, however, inherently puts a higher strain on the machinery.

One of the various objects of the present invention is to provide an improved roller die machine.

A roller die machine in accordance with the invention comprises an extruder portion having a discharge opening through which material is extruded from the extruder portion, and a roller die portion comprising a pair of co-operating rolls defining a nip to which material extruded through the discharge opening from th extruder portion is fed. The machine is so constructed and arranged that the co-operating rolls are transversely movable (towards and away from each ther) in planes which are oblique to a l ngitudinal axis of the machine. The longitudinal axis of the machine extends generally centrally of the discharg op ning, material being extruded from the discharge opening in a direction generally parallel with the longitudinal axis of the machine. In a preferred version of the machine the longitudinal axis of the machine coincides with the axis of the extruder portion and the axis of rotation of an extruder screw of the extruder portion. The longitudinal axis lies in a centre plane of the machine and the planes in which the rolls are movable are inclined to one another and to the centre plane, also. The oblique planes in which the co-operating rolls are movable preferably extend outwardly of the machine axis from a plane perpendicular to the centre plane and to the machine axis extending through the axis of the roll, to the side of the perpendicular plane remote from the discharge opening of the extruder portion. However the oblique planes may, in a machine in accordance with the invention, extend away from the machine axis on the side of the perpendicular plane nearest to the discharge opening of the extruder portion if so desired. Conveniently material is discharged from the extruder portion through an elongated discharge opening being generally parallel with the nip between the co-operating rolls andlying generally on the centre plane of the machine. Thus the oblique planes in which the co-operating rolls are trnasversely movable are also oblique to the direction in which material is expelled from the discharge opening of the extruder portion and to the general direction of flow of material to the rolls.

Preferably a machine in accordance with the invention comprises means e.g. hydraulic cylinders for moving the co-operating rolls toward and away from each other along their oblique planes. Conveniently the machine comprises a bearing at each end portion of each roll, each bearing being disposed in a guideway e.g. a slot in which its slides, to guide the bearings in the movement of the rolls thus to guide the rolls in the oblique planes.

Preferably the oblique planes of a machine in accordance with the invention in which the co-operating rolls move, are disposed at angles of between 15° and 60°, more preferably 30°, to the plane perpendicular to the machine axis.

Preferably in a machine in accordance with the invention in which the extruder portion comprises a longitudinal bore coaxial with the machine axis and an extruder screw mounted for rotation in the bore about the machine axis, the movable co-operating rolls are movable along their oblique planes away from th machine axis t an extent sufficient to permit withdrawal of the extrud r scr w from the end of th bor at which th discharge pening is disp sed.

A machine according to the invention may conveniently comprise a sensor, or sensors, arranged to detect the condition of the mater-

ial to be processed and to control op rating parameters of the machine thus to maintain the quality of the product. The sensor or sensors may be arranged to detect pressure of material supplied from the discharge opening to the nip e.g. by detecting the pressure exerted against at least one of the co-operating rolls, and to control the rotational speed of the co-operating rolls and/or the rotational speed of an extruder screw of the extruder portion. A sensor may also be arranged to detect the temperature of material expelled from the discharge opening and to control heat transfer in the machine.

There now follows a detailed description, to be read with reference to the accompanying drawings of an extruder roller die machine embodying the invention. It will be realised that this extruder roller die machine has been selected for description to illustrate the invention by way of example.

In the accompanying drawings:—

*Figure 1* is a diagrammatic view in side elevation and partially in section, of the illustrative extruder roller die machine; and

*Figure 2* is a fragmentary view, similar to Fig. 1 but with parts broken away of the illustrative machine.

The illustrative extruder roller die machine 10 comprises an extruder portion 12 and a roller die portion viz. a roller die head 14, having an upper roll 16 and a lower roll 18 co-operating to form a pressure nip therebetween. The extruder portion 12 includes a barrel 26 having an extruder screw 30, as shown in Fig. 2, rotatably disposed in a longitudinal bore 32 coaxial with a horizontal longitudinal axis X of the machine, which lies in a centre plane of the machine. The extruder screw 30 is driven through a suitable motor and gearing, arranged in a housing 34 on one end of the extruder portion 12.

A feed hopper 36 is disposed intermediate the extruder portion 12 providing means for feeding material to be extruded, into the longitudinal bore 32. A flange 40 is disposed at an output end portion (the left-hand end portion) of the barrel 26 as shown in Figs. 1 and 2. The flange 40 provides a means for attaching a head adapter 42 to the barrel 26 of the extruder portion 12. The illustrative machine 10 also comprises a transition section 46 which is disposed intermediate the head adapter 42 and a pair of roll support frames 50 having portions which are arranged generally parallel (only one of the frames 50 being shown). The transition section 46 has a passageway 52 extending therethrough. The passageway 52 is generally circular in cross-section where it abuts the head adapter 2, and it transforms to an elongated oval at a discharge opening thereof through which material is extruded from th extruder portion 12 to a receiving area of the upper and lower rolls 16, 18. The material is expelled from the discharge opening generally along th centre plan of th illustrative machine 10 and flows from the opening generally t wards the nip between the rolls 16, 18.

The upper and lower co-operating rolls 16, 18, form the pressure nip between one another immediately downstream of the discharge opening from the transition section 46. The upper and lower rolls 16, 18, are journalled at their ends, in an annular arrangement of bearings 58. The bearings 58 are each slidingly disposed in a guideway viz. an elongated slot 60 in each roll support frame 50. The bearings 58 are arranged one each around each end of the upper and lower rolls 16 and 18. The rolls are thus mounted for movement along planes which are oblique to one another and which intersect on the centre plane of the illustrative machine which passes centrally through the nip between the rolls. The oblique planes are each inclined to the centre plane at the same angle, though the plane of the upper roll 16 is inclined upwardly from the centre plane away from the extruder portion while the oblique plane of the lower roll 18 is inclined downwardly from the centre plane away from the extruder. Thus the oblique planes on which the rolls 16, 18 are transversely movable are also oblique to the direction in which material is expelled from the discharge opening of the extruder portion, i.e. the general direction of flow of material to the rolls.

The illustrative machine also comprises means for moving the rolls 16, 18 comprising a number of hydraulic cylinders 62. Each hydraulic cylinder 62 has a rod 64 extending therefrom with a shoe plate 66 engaging its associated bearing 58 on its distal end thereof. Each of the rolls 16, 18, thus has a pair of the hydraulic cylinders 62. Regulatable pressurization or depressurization of each respective pair of the hydraulic cylinders 62 by a proper pressure circuit, not shown, permits a transverse movement in either one or both the upper and lower rolls 16, 18, in a plane defined by their respective slots 60. The plane of transverse movement of each of the upper and lower rolls 16, 18, is oblique to vertical plane (which is perpendicular to the centre plane and the longitudinal machine axis X) by an angle A and an angle B, respectively, as shown in Fig. 2. The angles A and B are selected as required and may conveniently be from 15° up to 60°, the angle preferably being about 30°. The transverse movement of the upper and lower rolls 16, 18, is also oblique to the longitudinal axis X of the illustrative machine. The oblique planes may thus conveniently b inclined at angles of between 60° and 150° t one another.

Each roll 16, 18 is rotated by conventional driv means, not shown. Each roll 16, 18 has an array of heat transfer passageways 70 extending therethrough; the transition section

46 also has an array of heat transfer passageways 72. Th heat transf r passageways 70, 72, may be used for heating or co ling the machine elements, and are arranged with conduits for supplying and discharging heat transfer fluid. The illustrative machine further comprises one or more sensors e.g. a sensing and control device 75, e.g. a linear transducer of pressure device, to detect or measure the pressure of the extrudate at the respective rolls 16, 18. The control device 75 may act through appropriate electrical or hydraulic circuitry to control, i.e. reduce or increase, the speed of revolution of the rolls 16, 18, the speed of the extruder screw 30, or to alter the pressure supplied to the cylinders 62 to control the gap between the rolls, i.e. the width of the nip, to permit a larger or smaller gap between the rolls, 16 and 18. The control device 75 may also be temperature sensitive to control the heat transfer through the rolls 16, 18, or the transition section 46.

In operation of the illustrative machine 10, the extruder screw 30 is rotatably driven, and unprocessed material, for example plastic or rubber, is fed into the feed hopper 36. This material is processed by the screw 30, passes through the head adapter 42, and is discharged through the passageway 52 in the transition section 46 to the nip between the upper and lower rolls 16, 18, which form the material into a sheet of desired thickness and width, the gap between the rolls, the speed of the rolls and the pressure of material supplied to the nip, all influencing the dimensions of the sheet. The pressure applied to the hydraulic cylinders 62 maintains the rolls 16, 18 in desired positions relative one another. When it is desired to change materials running through the illustrative machine 10, a complete dismantling of the machine is not necessary, as was required in previously known roller die machines. Each roll 16,18 of the illustrative machine may be transversely withdrawn along its associated oblique plane by depressurizing the respective set of hydraulic cylinders 62 permitting retraction of the rods 64 and hence guided movement of each bearing 58 in its associated slot 60 in the die roll frame 50. A final slug of the first material, which was not discharged, may then be easily withdrawn from the bore 32 or the passageway 52 in the transition section 46, through the top or bottom of the frame 50 or through a passageway 80 which, on moving the rolls 16, 18 apart, is left clear between the parallel portions of the frame members 50 and between the upper and lower rolls 16, 18. The extrud r screw 30 may also b withdrawn through the passageway 80, if desired, (after removal of the transition section 46) after the upper and lower rolls, 16 and 18, are moved apart to their out rmost positions. During operation of the extrusion process, forces on the upper and lower rolls 16, 18 cause reactive forces to aris in the die r ller frame 50 and the barrel 26 (not merely forces acting on th rolls or hydraulic cylinders 62 alone) which, without benefit of the obliquely arranged upper and lower rolls, 16 and 18, might otherwise cause deformity or damage.

The load applied to the rolls of the illustrative machine is better distributed over the frame of the machine, and the obliquely adjustable rolls readily permit changes in thickness of extruded material output, or simple cleaning of the illustrative machine and removal of other allied equipment such as the extruder screw 30.

CLAIMS

1. A roller die machine comprising an extruder portion having a discharge opening through which material is extruded from the extruder portion, and a roller die portion comprising a pair of co-operating rolls defining a nip to which material extruded through the discharge opening from the extruder portion is fed, the machine being so constructed and arranged that the co-operating rolls are movable towards and away from one another in planes which are oblique to a longitudinal axis of the machine.

2. A roller die machine comprising a roller die portion comprising a pair of co-operating rolls defining a nip for receiving and processing material supplied thereto, each of the rolls being mounted to be transversely movable in a plane oblique to the direction of flow of material to the rolls.

3. A roller die machine comprising an extruder portion having a discharge opening through which material is extruded from the extruder portion, and a roller die portion comprising a pair of co-operating rolls defining a nip to which material extruded through the discharge opening from the extruder portion is fed, the machine being so constructed and arranged that the co-operating rolls are movable towards and away from one another and a centre plane of the machine in planes which are oblique to the centre plane.

4. A machine according to any one of the preceding claims comprising means for moving the movable co-operating roll or rolls towards and away from the other of the rolls in its oblique plane.

5. A machine according to claim 4 comprising bearings at each end portion of the co-operating rolls, the bearings being disposed in guideways to guide the bearings in the movement of the rolls.

6. A machine according to claim 5 wherein each guideway comprises a slot in which the associat d bearing slides to guide the rolls.

7. A machine according to any one of the preceding claims wherein the planes in which the movable co-operating rolls mov are disposed at angles of between 15° and 60° to a

plan perpendicular to the machin axis and to the centre plane.

8. A machine according to claim 7 in which the planes in which the movable co-operating rolls move are disposed at angles of 30° to the plane perpendicular to the machine axis.

9. A machine according to any one of the preceding claims in which the extruder portion comprises a longitudinal bore coaxial with the machine axis and an extruder screw mounted for rotation in the bore, and in which the movable co-operating rolls are movable in said oblique planes to an extent sufficient to permit withdrawal of the extruder screw from the end of the bore at which the discharge opening is disposed.

10. A machine according to any one of the preceding claims comprising a sensor arranged to detect the condition of the material and control operating parameters of the machine.

11. A machine according to claim 10 in which the sensor detects pressure of material, supplied from the discharge opening to the nip, and controls rotational speed of the co-operating rolls.

12. A machine according to claim 10 in which the sensor detects pressure of material, supplied from the discharge opening to the nip and controls rotational speed of an extruder screw of the extruder portion.

13. A machine according to claim 10 in which the sensor detects pressure of material, supplied from the discharge opening to the nip, and controls the width of the nip.

14. A machine according to claim 10 wherein the sensor detects the temperature of the material expelled from the discharge opening and controls heat transfer in the machine.

15. A roller die machine suitable for use in the manufacture of sheet material from plastics, rubber or the like constructed arranged and adapted to operate substantially as hereinbefore described with reference to the accompanying drawings.

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